An Examination of the Neutrality of US Money Supply on the Nigerian Economy

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Abstract

Literature on the classical dichotomy has focused on single economies with empirical evidence either substantiating or refuting the neutrality of money hypothesis. However this paper focuses on the neutrality of foreign money supply – in this case the US broad money supply – and its neutrality in both the long and short run on the real and nominal variables of the Nigerian economy. Based on data culled from the World Development Indicators (WDI) and time series methods such as the Augmented Dickey Fuller test, Johansen trace and maximum eigen value tests and the Vector Error Correction estimation; the US money supply was found to be non-neutral in both the long and short runs. US monetary policy was found to have profound impact on Nigerian interest rates followed by the consumer price index and the gross domestic product. This paper concludes that the US monetary policy must be a veritable factor considered in the design of monetary policy rules.

Introduction and Problem

Recent empirical findings on monetary neutrality in the macroeconomic literature has centered mostly on economies, not in relation to other economies, with the pros and cons of monetary policies arguing either in favor or to the contrary of the effectiveness of the same (Oi, Shiratsuka & Shirota, 2004; Noreiga, 2004; Puah & Hiew, 2010; Leong, Puah & Shazali, 2010; Arintoko, 2011). However the debate on the effectiveness of monetary policy on the real side of the economy in both the long and short runs have been raging on since the work of John Maynard Keynes in 1936, popularly known as 'The General Theory'. In Keynes' view of money was relevant as a policy instrument for shoring up aggregate demand and restoring long run full employment equilibrium and this was later substantiated by the neoclassical synthesis of John Robert Hicks in his IS-LM framework (Snowdon & Vane 2005; Rode, 2012). These theories as they contrasted the classical views of the neutrality of money were subjected to empirical analysis in several countries.

Substantial literature on monetary neutrality sprang up in the late 1980s into the early 1990s (Jean-Tang 2016). Hammond (1990) investigated this phenomenon, the neutrality of money in 20 OECD countries and provides evidence of the non-neutrality of money given that money supply grows at a rate slower than output growth hence making money non-neutral in the short run. These results were confirmed in the UK using quarterly data by Malliaropulos (1995) as it is was also discovered that money is non-neutral in the short run. Investigating two south American countries, Argentina and Brazil, Bae and Ratti (2000) posited empirical findings that rejected the conjecture of the superneutrality of money in both economies and their findings remained robust to slight modifications test specifications used in their study. Extending the study beyond just Argentina and Brazil, Noriega (2004) includes in his sample the economies of US, Italy, Canada,

UK, Denmark, Mexico and Sweden. Findings from this study discovered that the neutrality of money was empirically debunked in all but the US and Denmark where their study results failed to arrive at a conclusion. Evidence in defiance of the neutrality of money was further buttressed in recent studies by Puah, Habibullah and Shazali, (2008) and more recently Tang, Puah, Affizzah, (2013) and Tang, Puah, Affendy and Affizzah (2015) studying the economies of Singapore and Indonesia conclude the non-neutrality of money.

These studies though providing evidence for individual economies on the neutrality of money have left the possible effect of cross border monetary policies on economies – and hence the neutrality or non-neutrality of international monetary aggregates. The global financial crisis of the early 2000s sent a clear message around the world; that international monetary and macroeconomic spillovers could be detrimental to the real sector performance of the relatively weaker developing countries (Green, King & Miller-Dawkins, 2010; Dolphin & Chappell, 2010). With special emphasis on Nigeria, whose nexus with the US's monetary environment is under investigation in this paper, literature makes it clear that Nigeria was badly hit in both real and monetary terms by the global financial crisis that emanated in the US. In the wake of the crisis, the Central Bank of Nigeria had to inject more than 400 billion naira to forestall a systemic collapse in the banking sector and boost dwindling aggregate demand and this occurred despite the financial consolidation reform measures expected to shore up commercial bank liquidity and support real growth since 2005 (Igbatayo, 2011; Ngwube & Ogbuagu, 2014). Other real effects of the global financial crisis include an increase in the unemployment rate from 11.9% to 15.9% in 2008, industrial output share of the GDP declined from 3.17% in 2004 till 2.56% in 2008 and the building and construction share of GDP also declined from 1.48% in 2004 to 1.26% in 2008 (Atan 2013; CBN, 2016).

These figures suggest a strong nexus between the happenings in the US monetary system and the real sector of the Nigerian economy. Hence the success or the failures of monetary policy in the US could portend opportunities or threats to the real sector in Nigeria. However a more penetrating question which lies unanswered in the literature on Nigerian-US economic relations is; is the US's monetary policy neutral in its effect on the Nigerian real sector? While most literature on monetary neutrality have focused on the neutrality of the CBN's monetary policies on the real sector of the Nigerian economy as seen in the works of Babatunde and Shuaibu, (2011); Hassan (2012); Chinaemerem and Akujuobi, (2012); Bandele et al, (2014); Adigwe, Echekoba, Justus and Onyeagba, (2015) literature is yet to consider the neutrality of US monetary policies on the Nigerian real sector. The choice of the neutrality of the US's monetary policy is anchored on the extensive real and financial linkages between the two economies, as the dollar is Nigeria's major reserve currency (Irefin & Yaaba, 2011); the US is one of Nigeria's major trade partner (Odularu, 2008; Obiora 2009), foreign direct investment and portfolio flows between Nigeria and the US are quite substantial.

Towards addressing the objectives of testing the empirically the neutrality of US money supply on Nigerian real and nominal variables, this study proposes a transmission mechanism anchored on the capital account section of the balance of payment equilibrium in a IS-LM-BP framework in the next section. Following this section, the long and short run neutrality of US money supply is investigated with results supporting the non-neutrality of US money supply on Nigerian real and nominal variables. Consequently a discussion of the findings is presented and recommendations for the incorporation of the findings of this paper into the design of the Central Bank of Nigeria's monetary policy rules.

Theory and Method

The neutrality of money supply of the US on the real aggregates in Nigeria would involve the design of a general equilibrium framework involving the two economies based on the IS-LM—BP model. On assuming the long run equilibrium where the aggregate supply is: gdp_t the at equilibrium: $gdp_t = c_t + i_t + g_t + nx_t$ which shows that the gross domestic product for Nigeria is the sum of consumption c_t, investment i_t, government expenditure g_t and net exports nx_t. The consumption function based on the exposition of Alimi, (2015); Khan, Anwar, Ahmed and Kamal, (2015) is given by the function: $c_t = c(c_{t-1}, r_t, gdp_t, m_t/p_t)$ while the investment function based on the framework of Acosta and Loza, (2005) and Ambachew (2010) is defined as: $i_t = i(c_t, g_t, nx_t, s_t, dp_t/p_t, m_t/p_t)$ where s_t is the exchange rate, p_t is the price level and m_t is the nominal broad money supply. The government expenditure is assumed to be exogenous and net exports is defined by the balance of payment identity given as: $nx_t = k(r_t^* - r_t)$ where the function k represents the capital account balance and r_t^* (Schmitt-Grohe & Uribe, 2014).

Assuming monetary equilibrium in the US, defined by the equation: $m_t^*/p_t^* = m(gdp_t^*, r_t^*)$ and based on this equation, in the long run the relationship between nominal money supply and the interest rates in the US will be: $dm_t^* = p_t^* m_{r^*} dr_t^*$ where $dgdp_t^* = 0$ and $dp_t^* = 0$. However from the balance of payment equation for Nigeria it is seen that $dnx_t = k_{r^*} dr_t^* - k_r dr_t$ and hence $dnx_t = (k_{r^*}/p_t^* m_{r^*}) dm_t^* - k_r dr_t$.

Based on the components of the aggregate expenditure identity for Nigeria the following is derived: $dgdp_t = c_r dr_t + c_{gdp} dgdp_t + c_m dm_t/p_t - c_m(m_t/p_t^2) dp_t + i_r dr_t + i_r dr_t + i_g dg_t + i_m dm_t - i_p(m_t/p_t^2) dp_t + dg_t + dnx_t$ on substituting in the net exports equation

embodying the effect of US money supply: $\left(1 - c_{gdp}\right)dgdp_t = (c_r + i_r - k_r)dr_t + (c_m + i_m)dm_t/p_t - (c_m + i_p)(m_t/p_t^2)dp_t + (1 + i_g)dg_t + (k_{r^*}/p_t^* m_{r^*})dm_t^*$.

Based on the equation just derived, the neutrality of money supply in the US on the real aggregates gdp_t, r_t as well as the nominal variables m_t, p_t - assuming government expenditure to be given and constant – is depicted by the coefficients:

$\partial gdp_t/\partial m_t^* = k_{r^*}/p_t^* m_{r^*}\left(1 - c_{gdp}\right) > 0$,where $0 < c_{gdp} < 1; k_{r^*}/p_t^* m_{r^*} > 0$

$\partial r_t/\partial m_t^* = k_{r^*}/p_t^* m_{r^*}(k_r - c_r - i_r) > 0$ where $k_r - c_r - i_r > 0; k_{r^*}/p_t^* m_{r^*} > 0$

and

$\partial m_t/\partial m_t^* = -k_{r^*} p_t/p_t^* m_{r^*}(c_m + i_m) < 0$ where $0 < c_m + i_m < 1; k_{r^*}/p_t^* m_{r^*} > 0$

$\partial p_t/\partial m_t^* = k_{r^*} p_t^2/p_t^* m_{r^*} m_t\left(c_m + i_p\right) > 0$ where $0 < c_m + i_p < 1; k_{r^*}/p_t^* m_{r^*} > 0$

On a priori grounds it is expected that an increase in the US money supply would have a positive impact on the Nigerian gross domestic product, money supply and general price level but a negative impact on the Nigerian money supply. However the effect of the US money supply would be neutral if and only if $k_{r^*} = 0$ and hence it is expected that the effectiveness of US money supply on the Nigerian economy is anchored on the response of the Nigerian capital account to foreign interest rate shocks.

Based on the theoretical model: $\left(1 - c_{gdp}\right)dgdp_t = (c_r + i_r - k_r)dr_t + (c_m + i_m)dm_t/p_t - (c_m + i_p)(m_t/p_t^2)dp_t + (1 + i_g)dg_t + (k_{r^*}/p_t^* m_{r^*})dm_t^*$, the below empirical model is framed in the light of the vector autoregressive model:

$$lnz_t = \theta_0 + \sum_{i=1}^{k} \theta_i lnz_{t-i} + u_t$$

where k is the optimal lag length and z_t is the vector of variables ($lngdp_t\ lnp_t\ r_t\ \ lnm_t\ lnm2_t$) where $lnm2_t$ is the log transformation of the US broad money supply, $lngdp_t$ is the log transformation of the gross domestic product, lnm_t is the log transformation of the Nigerian broad money supply, lnp_t is the log transformation of the price level and r_t is the Nigerian prime lending rate.

Towards estimating this model, the unit root test is conducted with the aid of the Dickey and Fuller (1979) test. Consequently, upon determining the orders of integration of the variables in the equations this study shall proceed to conduct the test for cointegration using on of the following tests for cointegration; the Engle and Granger (1987) single equation procedure, the Pesaran et al (2001) bounds testing procedure or the Johansen multivariate test for cointegration. The expected existence of unit roots in the variables under consideration thus suggests the estimation of an error correction mechanism for each of the equations in the model. Upon estimating the vector autoregressive model variant suited for this study, the attendant diagnostic tests: the Q and adjusted Q tests for autocorrelation and the White (1980) test for heteroscedasticity are conducted. Annual data from the World Development Indicators (WDI) with a time frame from 1970 till 2014 is employed in this study.

Empirical Analysis

Visualizing the data involved in this study it can be observed that the Nigerian gross domestic product trends linearly while the linear trend for the interest rate is quite weak due to the spikes in the interest rate recorded in 1990 (25.3%), 1993 (31.6%) and 2002 (24.8%). The Nigerian

consumer price index, Nigerian broad money supply and the US broad money supply all tend to have a non-linear trend as the paths of the series appear to be U-shaped.

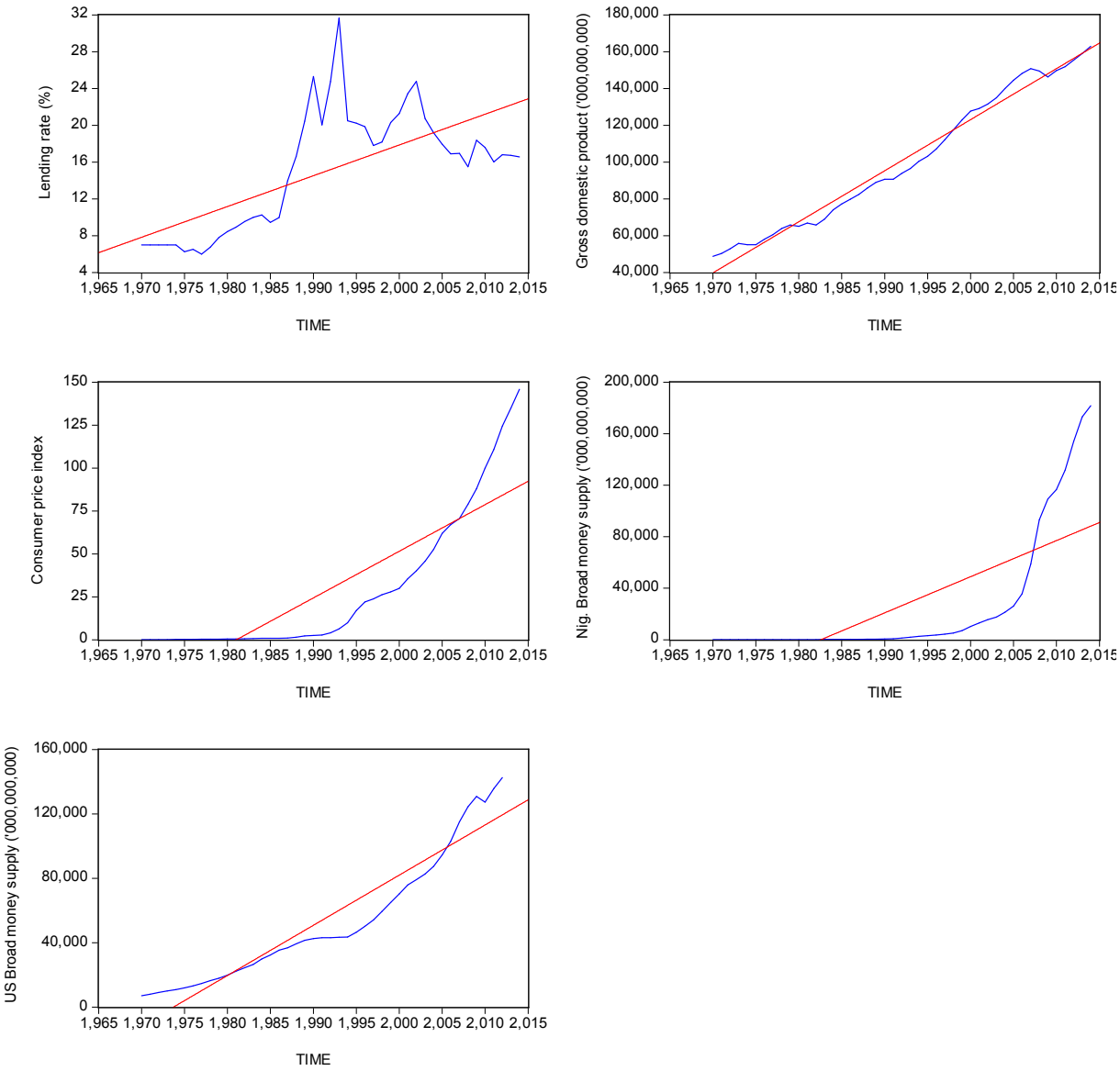

Figure 1: Trend analysis of Nigerian broad money supply, US broad money supply, consumer price index, interest rate and gross domestic product

The US broad money supply closely approximates a linear trend with a steady growth rate over time since 1970. On the whole it is clear that all the series have a positive trend – linear and quadratic – with the exception of the interest rate which has rose sharply till the early 1990s and declined with some level of volatility till the 2015.

Unit root and Cointegration testing

The unit root testing with the aid of the augmented Dickey Fuller test shows that all the variables in the study are stationary at first difference after providing for trend and intercept. The implication of this is that all the variables record first order integration.

Based on this finding, the test for cointegration is condiucted with the aid of the Johansen cointegration trace and maximum eigen value tests. This is presented in the next section.

Table 1 Augmented Dickey Fuller test for unit roots

Series	ADF at level Prob.	ADF at first difference Prob.	Equation specification	Order of integration
R	0.6265	0.0959*	Trend and intercept	I(1)
LOG(GDP)	0.7141	0.0016***	Trend and intercept	I(1)
LOG(P)	0.6744	0.0163**	Trend and intercept	I(1)
LOG(M2NG)	0.2886	0.0493**	Trend and intercept	I(1)
LOG(M2US)	0.5375	0.0960*	Trend and intercept	I(1)

Source: constructed by author. *denotes 10% statistical significance, **denotes 5% statistical significance, ***denotes 1% statistical significance.

The results of the Johansen cointegration test indicates four cointegrating equations at the lag length unity, which is buttressed by the AIC, SIC, HQ and FPE information criteria, and this is indicated by the trace and maximum eigen value statistics 7.75 with the probability value 0.005. Having established cointegration, four cointegrating equations are estimated such that the long run effect of US money supply on Nigerian real and money supply variables can be examined. The results of the long run estimation can be found in the next section in the table 3

Table 2 Johansen cointegration test

Hypothesized No. of CE(s)	Trace Statistic (prob. value)	Max-eigen Statistic (prob. value)
None	79.50242 (0.0069)***	27.92569 (0.2169)
At most 1	51.57646 (0.0215)**	20.37169 (0.3160)
At most 2	31.20477 (0.0342)**	12.62659 (0.4872)
At most 3	18.57818 (0.0166)**	10.83068 (0.1629)
At most 4	7.747501 (0.0054)***	7.747501 (0.0054)***

Source: constructed by the author. ***indicates 1% statistical significance, **indicates 5% statistical significance. VAR(1) test specification is based on the condition of no intercept or trend in the cointegrating equation or test specification.

Long Run and Short Run Impact of US Broad Money Supply on the Nigerian Real and Nominal Variables

The estimation of the cointegrating equations as seen in the table 3 shows that the US money supply according to theory has a positive and statistically significant impact on all the real and nominal variables except the Nigerian money supply LOG(M2NG) growth. The impact of the US money supply is felt mostly in the interest rate with an impact coefficient of 24.10% followed by the price level with an impact coefficient of 2.68% and lastly the gross domestic product growth with an impact coefficient of 0.41%.

These figures suggest that the US money supply is not neutral in its impact on the real and nominal variables in the Nigerian economy over the long run with its impact felt in the gross domestic product, the inflation rate and the domestic interest rate.

Table 3 Cointegrating equation estimation output

Endogenous variables	LOG(GDP)	LOG(P)	R	LOG(M2NG)
	Coefficient (standard errors) [t-statistics]	Coefficient (standard errors) [t-statistics]	Coefficient (standard errors) [t-statistics]	Coefficient (standard errors) [t-statistics]
LOG(M2US(-1))	0.408651 (0.02663) [15.3467]***	2.681390 (0.22312) [12.0179]***	24.09618 (5.81628) [4.14288]***	0.223191 (0.88159) [0.25317]
C	-18.00057	76.39979	683.4561	-19.02232
Diagnostics and Summary				
R-squared	0.342701	0.733967	0.345159	0.452682
Adj. R-squared	0.151872	0.656732	0.155044	0.293783
F-statistic	1.795856*	9.502987**	1.815526*	2.848870**
White test for heteroscedasticity Chi-square stat (prob value)	287.8635 (0.2174)			
Q-stat range (prob value range)	7.28<Q<232.11 (0.51<prob value<1)			
Adjusted Q-stat range (prob value range)	7.55<Q<278 (0.18<prob value<0.54)			

Source: constructed by the author. ***indicates 1% statistical significance, **indicates 5% statistical significance, *indicates 10% statistical significance

Diagnostic tests of the VECM(1) specification with which the vector error correction and cointegrating tests were conducted indicate that the results obtained in the cointegrating equation are quite suitable. The White test for joint heteroscedasticity indicates a statistic of 287.86 with a probability value of 0.21 suggesting that the non-rejection of the hypothesis of no heteroscedasticity. The Q-stat and adjusted Q stat tests for autocorrelation presents values of their respective statistics within in the ranges $7.28<Q<232.11$ and $7.55<Q<278$ with the respective ranges of probability values $0.51<p<1$ and $7.55<p<0.54$. These figures suggest that the hypothesis that there is no autocorrelation up to the lag length 12 is not rejected by both the Q-test and the adjusted Q-test. In all four specifications, more than 34% of the systematic variation in the dependent variable is accounted for by the regressors. Though these values are suggests poor fit the F-statistics gives more credence to the overall statistical significance of the

regressions as the F-statistic for all four specifications are statistically significant at the 1%, 5% and 10% levels.

Short run dynamics of the Impact of US Broad Money Supply on Nigerian Real and Nominal Variables

Short run neutrality of the US money supply is examined in the section and the figure 2 gives some insight into this as shown below:

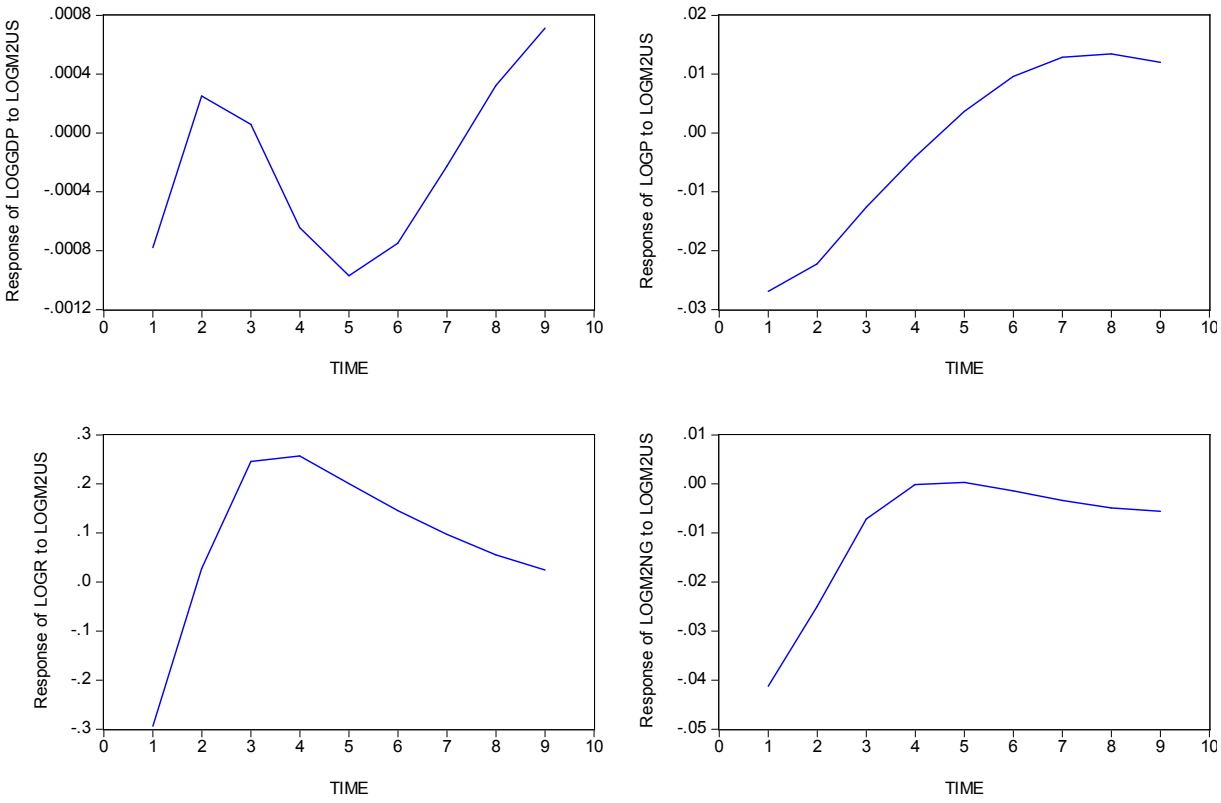

Figure 2 Impulse Responses of GDP, P, R and M2NG to M2US shocks

The figure 2 indicates that a one standard deviation shock to the US money supply has the effect of engendering an initial increase in the growth of the gross domestic product to a peak of 0.025% in the second year followed by a trough of -0.097% in the fifth year and yond this period

the growth in the gross domestic product accelerates beyond the second year peak. The consumer price index responds by a much higher magnitude than the gross domestic product as it grows from -2.7% in the first year to a peak of 1.3% in the eight year and averages this growth rate since the 8th year. The Nigeria broad money supply and interest rate both follow a similar pattern, expectedly, in response to the US broad money supply as both follow and inverted U shape path. Interest rates grew to a peak growth rate of 26% while the response of the Nigerian broad money supply was mostly negative growth which decelerated from the -4.1% in the first year to 0% in the fourth year and stabilized at an average growth rate of -0.5% since then.

Discussion of Results and Conclusions

The results of this study point to the fact that the US money supply is not neutral in its impact on the real and nominal variables of the Nigerian economy – another violation of the classical dichotomy of the impact of money – and hence it is pertinent that monetary policy in Nigeria consider the spillover effects of US monetary policy. With the domestic interests being heavily influenced by the US money supply it is expected that the ease and constraints on liquidity in the Nigerian economy will be swayed by the US money supply. In the absence of US-Nigerian monetary policy coordination the CBN's policy may become pro-cyclical and hence exacerbate instability in the Nigerian financial system.

As is the case with the domestic interest rate is the case of the consumer price index and by implication the inflation rate. The US money supply has profound impact on the consumer price index sustaining the inflation rate at 2.68%. With this contribution to the inflation rate, among other factors, the monetary policy rules which are devoid of the exogenous effect of the US money supply (Iklaga, 2008; Kelikume, Alabi & Ike-Anikwe, 2016), must be revised.

While a paltry 0.41% growth in the GDP is accounted for by the US money supply, cumulatively this could be substantial. Thus policies that boost growth need to be aware of pro cyclical effect of US money supply. The pro cyclical effect of US broad money supply will augmented stylized facts about the Nigerian economy and would be relevant for policy formation aimed at targeting growth at different stages of the business cycle.

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